CALFED ECOSYSTEM RESTORATION PROGRAM
DRAFT STAGE 1 ACTIONS
SACRAMENTO-SAN JOAQUIN DELTA

San Joaquin River Habitat Corridor Stage 1 Actions

The Stage 1 objective for the San Joaquin River is to restore a contiguous habitat corridor of tidal marsh, shaded riverine aquatic, riparian, and floodplain habitats. The San Joaquin is an important region for many native fishes including delta smelt, splittail and salmonids. Little shallow-water and riparian habitat remains on the San Joaquin River. Water quality is poor for much of the year; there is low dissolved oxygen, high salinity, many pesticides, and water temperature is often elevated. Restoration opportunities are limited by the requirements of flood control, levee maintenance and dredging for ship navigation. Reconnaissance studies should be initiated to evaluate opportunities for wetland and floodplain habitat in the river channel, on levees, and for incorporation into the design of levee repairs. CALFED Water Quality Program actions will also enhance the San Joaquin River restoration efforts in Stage 1.

Action (Restoration Coordination Program action type in parentheses)	**Rationale**	**Adaptive Management Design**	**Linkages** (Category III, related programs, etc.)
1. Conduct a feasibility study and, as appropriate, construct setback levees or shallow water berms along the San Joaquin River between Stockton and Mossdale where practicable to increase channel capacity and to restore floodplain and riparian habitats. *(floodplain/marsh, river geomorphology)*	Restoration of the San Joaquin River corridor would improve an important rearing and migration corridor for fishes and would provide information on our ability to reestablish floodplain processes in the Delta. There is the potential to utilize clean dredge material available from the Port of Stockton for in-channel restoration. Evaluate benefits to splittail spawning.	• Determine the feasibility of larger-scale restoration of riparian floodplain habitat and flood processes in the Delta. • Evaluate species utilization of riparian and floodplain habitats, including benefits to splittail spawning and outmigrant San Joaquin salmon mortality.	VAMP CALFED Levee Program Comprehensive Study FY '97 Category III funds have been used to purchase fee title or easements on over 6,000 acres of land adjacent to the San Joaquin National Wildlife Refuge. FY '97 Category III funds have been used to help screen the Banta-Carbona Irrigation District's diversion.

2. Evaluate species utilization of shallow-water wetlands on Venice Tip and McDonald Tip. *(population management)*	Knowledge of the utilization of shallow-water and floodplain habitats along the San Joaquin River by fish such as splittail (for spawning) and juvenile salmon (for rearing) is limited.	• Determine San Joaquin River salmon smolt survival through Coded Wire Tag (CWT) (paired) experiments to assess baseline survival and the change in survival following restoration. • Determine the residence time and rearing of San Joaquin River salmon, delta smelt, and other native species.	VAMP
3. Restore in-channel islands and experiment with multiple techniques to allow natural sediment accretion to create new in-channel islands and to protect in-channel shallow-water habitat from boat wakes. *(floodplain/marsh, river geomorphology)*	Restoration of in-channel islands may be the most effective means to improve habitat continuity along the San Joaquin. There is some existing in-channel habitat (although diminished from boat wakes and channel modifications) that can be enhanced and a considerable amount of new habitat can be accommodated in the wide channel of the San Joaquin River. Existing in-channel habitat can be augmented and new habitat created using Stockton Ship Channel dredge material and by encouraging natural sediment deposition.	• Evaluate the need to armor in-channel islands. • Identify species colonization and succession rates.	CALFED Levee Program

North Delta Habitat Corridor Stage 1 Actions

The Stage 1 objective for the North Delta is to restore a large, contiguous habitat corridor connecting a mosaic of tidal marsh, seasonal floodplain, riparian and upland grassland habitats in the Yolo Bypass, Cache Slough Complex, Jepson Prairie, Prospect Island, Little Holland Tract, Liberty Island, and Steamboat Slough. This suite of actions is a high priority because there is the potential to effectively restore and connect multiple habitat types into a functional habitat corridor. The habitat corridor will improve an important rearing, migration, and spawning area for anadromous and resident fishes as well as important habitat for waterfowl, special-status plants, giant garter snake, and other species. This suite of actions provides a unique opportunity to restore the only functional floodplain ecosystem in the Delta at a large scale, low cost, and with high information and learning potential. Restoration at this location offers the ability to address major restoration issues and uncertainties including species utilization of flood bypasses, ability to control introduced aquatic and riparian plants, tidal marsh restoration techniques, and experimentation on the relationship between variable salinity regimes, physical habitat and species.

The Restoration Coordination Program has funded many projects that are critical to restoring this habitat corridor and may fund other projects in FY 99. Before major actions are taken in Stage 1, the results of the previously funded projects will be assessed and the proposed Stage 1 actions will be refined accordingly. Many of the projects listed below will require planning studies and outreach to local landowners, recreation interests, and coordination with other CALFED Programs.

The objective for the Yolo Bypass is to restore flows, fish passage, and seasonal wetland habitat consistent with flood management requirements. The Yolo Bypass is an artificial floodway that provides extremely important habitat when flooded for delta smelt, splittail spawning, and salmon rearing. When not flooded, the Bypass provides critical habitat along the Pacific Flyway for tens of thousands of birds. There is the potential to enhance this habitat at a low-cost and large scale because restoration will not have significant impacts to existing agricultural practices, Bypass land is either publicly-owned or privately-owned land with flood easements, and restoration actions can be bundled with flood control improvements. There is an unknown, potential benefit by improving salmon passage through the major Bypass slough, the Tule Canal/Toe Drain, to the Sacramento River and Cache Creek.

Potential restoration actions in the Yolo Bypass must be modeled for potential flood control impacts and will only go forward if compatible with flood control requirements or in conjunction with flood management improvements. The increased channel roughness of new riparian habitat in Tule Canal/Toe Drain in the Bypass may be mitigated by enlarging openings in the railroad causeway with the potential for net flood control benefit in the Bypass.

Action	Rationale	Adaptive Management Design	Linkages
4. Increase the duration of Yolo Bypass flooding in winter and spring by modifying the Fremont Weir to allow lower-stage flood flows of the Sacramento River to pass through the Yolo Bypass. *(floodplain/marsh)*	Currently the weir is constructed to allow flows over 60,000 cfs to spill into the Bypass to reduce flood risk in the Sacramento and American rivers; consequently, the Bypass only receives flow from the Sacramento River during high flow events. It is desirable to increase seasonal flooding in order to benefit native fishes, including splittail, salmon and delta smelt. This can be accomplished by lowering the height of a portion of the weir. Lower-stage floods would not flood the entire Bypass but primarily the eastern area of the Bypass, thereby creating seasonal wetlands adjacent to the perennial wetlands of the Tule Canal/Toe Drain.	▪ Study invasion of exotic plants such as *Arundo* and tamarisk. Develop control measures	Effects of wetland restoration on mercury methylization. Yolo Bypass Habitat study (fish use). Jepson Prairie SRA restoration. Lower Putah Creek watershed stewardship. Bypass landowner outreach.
5. Construct a fish ladder at Fremont Weir to provide for fish passage through the Tule Canal/Toe Drain to the Sacramento River. *(fish passage)*	Improved flows through the Bypass will attract adult anadromous fish that must navigate past the weir to reach their natal spawning habitat on the upper Sacramento River. Providing passage around the Fremont Weir will help prevent migratory fish from being stranded.		

6. Improve year-round flow and fish passage through the Tule Canal/Toe Drain: ▪ construct new channels connecting the slough with the Putah Creek, Cache Creek and the Fremont Weir fish ladder; ▪ better connect the slough by enlarging culverts, etc. to allow fish passage at low flows; ▪ screen irrigation diversions from the slough; ▪ restore riparian habitat along the slough, including on the east levee. *(floodplain/marsh, fish passage)*	The distributaries of Putah and Cache creeks are not well connected to the Tule Canal/Toe Drain slough, and therefore do not provide fish passage during low-flow periods.		
7. Acquire water to sustain higher summer and fall flows through the Tule Canal/Toe Drain. *(water management)*	It may be beneficial to improve summer and fall flows through the Bypass. This would require purchasing additional water to sustain flow through the Tule Canal/Toe Drain throughout the year. If it is determined that additional flow would primarily benefit non-native fishes, this action will not be implemented.	▪ Native vs. non-native species utilization.	
8. Conduct a feasibility study of the opportunities to reduce fish stranding in the Bypass. *(fish passage, population management)*	There are potentially significant impacts to populations of juvenile salmon and Delta smelt when stranded. Fish stranding can be reduced by creating new channels through ponded areas to improve drainage to the Tule Canal/Toe Drain.		North Delta salmon rearing study.

9. Conduct a feasibility study to increase flood flow capacity in the Yolo Bypass to compensate for lost flood capacity from Bypass restoration. If appropriate, enlarge the openings of the railroad causeway. *(floodplain/marsh)*	Restored riparian habitat in Tule Canal/Toe Drain will increase the roughness of the Bypass, reducing its flood conveyance capacity. The railroad causeway restricts the flow of floodwaters through the Bypass and also creates conditions that tend to strand larval, juvenile, and occasionally adult fish when the water recedes. The small openings through the railroad causeway can be enlarged to increase net flood capacity of the Bypass and reduce stranding effects.		
10. Evaluate conditions favorable to splittail spawning (wetted perimeter, depth, timing, duration). *(population management, water management)*	Splittail are known to use the Bypass and other flooded seasonal habitats to spawn, but the optimal spawning conditions are unknown. By studying spawning behavior in different water year floods may be used to better manage Bypass flows to benefit splittail.		
11. Plan and implement restoration of tidal and seasonal wetlands on Little Holland Tract, Prospect Island, Liberty Island, and lower Yolo Bypass in conjunction with the eradication and control of nuisance, introduced aquatic plants. *(floodplain/marsh, introduced species)*	Prospect, Liberty, and Little Holland are ideal locations to restore tidal marshes. Most of the land is publicly owned, therefore it will reduce the need to convert additional agricultural land to habitat. Since they are located at the outlet of the Yolo Bypass, they are more susceptible to flooding. The islands are not as subsided as other Delta islands, so they will require less effort to construct suitable land elevations for habitat. Restoration can build upon existing tidal marsh habitat on the margins of these islands. Tidal marsh restored on these islands will connect with the important riparian and seasonal floodplain habitats in the Yolo Bypass, tidal marsh and riparian habitats in the Cache Slough complex, Steamboat Slough, and the Sacramento River.	• Evaluate multiple tidal marsh restoration techniques. • Evaluate species colonization and succession. • Study native vs. non-native species use of shallow-water habitats.	Prospect Island acquisition, restoration and monitoring. FY '97 Category III funds for acquisition of Liberty Island for habitat restoration. Lindsey Slough levee habitat enhancement. Hastings Tract fish screen. North Delta salmon rearing study.

12. Develop a plan to design and evaluate tidal marsh restoration in the North Delta. Study the relationship between salinity gradients, salinity variability, and physical habitat and the effect on species in the tidal North Delta. *(floodplain/marsh, population management, introduced species)*	Restoration in the North Delta provides an opportunity to learn about species utilization of shallow-water habitat and salinity gradients. The seasonal and interannual variations in Delta inflow created a variable salinity regime. Construction of reservoirs, water diversions, and modification of Delta islands have reduced the variability of flow and salinity conditions. Native plant, wildlife and fish species evolved with the variable flow and salinity regimes. Reducing the variability may have provided competitive advantage to non-native. Developing a plan to experiment with flows and salinity gradients may identify conditions that benefit native species.	• Extent to which physical habitat may be limiting native and introduced species. How salinity gradients and variability affect conditions and species in shallow-water habitats. • Calibration of models to evaluate changes in Delta hydraulics resulting from wetland restoration.	North Delta salmon rearing study. USGS sediment transport and availability. Hydraulic modeling.
13. Develop measures to rehabilitate and restore riparian and shaded riverine aquatic habitat corridor along Steamboat Slough, an important fish migration corridor. *(floodplain/marsh, river geomorphology)*	Steamboat Slough is an important migratory corridor for Sacramento River salmon. Habitat conditions are more favorable in Steamboat than the Sacramento River, and there is little opportunity to restore riparian habitat on the large, federal levees of the Sacramento River. Attempts should be made to protect existing habitat from boat wakes and other activities associated with heavy recreational use on Steamboat Slough. Existing boat speed restrictions have not been effective in stopping degradation of existing habitat.	• Sacramento salmon smolt survival. CWT (paired) experiments to assess baseline and changes.	
14. Linkage with Sacramento River Basin Action: Cache Creek tamarisk removal, riparian restoration and mercury control. *(introduced species, floodplain/marsh, water quality)*	Cache Creek is degraded by mercury from an upstream mercury mine and from introduced plants. Introduced tamarisk is an invasive riparian plant that provides poor habitat and has very high water consumption rates. Elimination of tamarisk and restoration of native riparian plants will improve habitat quality and may help to restore flow to the creek. Restoration of riparian vegetation must occur in conjunction with efforts to stabilize sediments laden with mercury to prevent methylization of mercury in the aquatic environments of Cache Creek and Yolo Bypass. The CALFED water quality program will evaluate the extent of mercury contamination and will develop control measures in the Cache Creek watershed and in the Bypass.	• Alternative methods to control mercury methylization. • Alternative methods to control tamarisk. • Impacts of mercury on Cache Creek and Yolo Bypass organisms.	CALFED Water Quality Program and Watershed Management Program

EAST DELTA HABITAT CORRIDOR STAGE 1 ACTIONS

The objective for the East Delta is to restore a large, contiguous corridor containing a mosaic of habitat types. The East Delta is an important region for its diversity of plant, fish, and avian species, functioning floodplain on the Cosumnes River, a relatively natural hydrograph, and because it offers the best opportunity to evaluate and restore natural ecological functions in the Delta. Stage 1 actions will focus on tidal marsh and riparian habitat restoration on the South Fork of the Mokelumne River, East Delta dead-end sloughs, Georgianna Slough, Snodgrass Slough and the Cosumnes River floodplain.

Action	Rationale	Adaptive Management Design	Linkages
15. Restore and rehabilitate a contiguous corridor of riparian, shaded riverine aquatic, tidal freshwater, and seasonal and perennial habitats along the South Fork of the Mokelumne River. *(floodplain/marsh, river geomorphology)*	Restoration of this corridor will bolster rearing and migration of salmon from the Mokelumne and Cosumnes rivers. It is an opportunity to restore critical ecological processes including flood processes.	• Evaluate the benefits of large-scale restoration of ecological processes on the Mokelumne.	FY '97 Category III funds for floodplain land along the lower Cosumnes River. Mokelumne River watershed planning. Woodbridge ID fish passage project.
16. Restore tidal marsh and riparian habitats on McCormack-Williamson Tract in conjunction with other flood control measures. *(floodplain/marsh, river geomorphology)*	McCormack-Williamson, a highly flood-prone tract, is planned to be acquired. Breaching McCormack-Williamson levees and restoring the tract to tidal marsh and riparian habitat in conjunction with other flood control efforts can relieve flooding pressure in the North Delta and improve habitat connectivity with the Cosumnes River floodplain. The tract is ideal for restoration to tidal and riparian habitats due to favorable land elevations.	• Evaluate species colonization and succession. Evaluate the effects of natural process restoration on the evolution of riparian and tidal marsh habitats.	McCormack-Williamson acquisition and restoration. Sacramento Co. and North Delta Flood Mgmt. FY '97 Category III funds for floodplain land along the lower Cosumnes River.
17. Restore tidal marsh and riparian habitats on Georgianna Slough. *(floodplain/marsh, river geomorphology)*	Major migration corridor for salmon. Substantial losses to salmon occur due to predation and entrainment.	• Evaluate benefits of restoring additional habitats in areas of high predation and entrainment.	

18. Restore tidal marsh and riparian habitats on East Delta sloughs in conjunction with control of non-native aquatic plants. *(floodplain/marsh, river geomorphology, introduced species)*	Backwater habitats are critical habitat for Delta native fishes.		
19. Restore in-channel islands and experiment with multiple techniques to allow natural sediment accretion to create new in-channel islands and to protect in-channel shallow-water habitat from boat wakes. *(floodplain/marsh, river geomorphology)*	Boat wakes have significantly reduced the quantity and quality of in-channel habitat. Multiple approaches should be used to protect existing in-channel islands including limiting boat speeds in sensitive areas, and installing wave attenuation structures, and also to encourage natural creation of islands.		
20. Develop incentives for wildlife-friendly agriculture on Staten Island. *(education)*	Agricultural fields provide surrogate habitat for resident and migratory wildlife.		

Central and West Delta Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
21. Restore Frank's Tract to tidal marsh using clean dredge materials and natural sediment accretion in conjunction with the eradication and control of nuisance, introduced aquatic plants. *(floodplain/marsh, river geomorphology, introduced species)*	Frank's Tract can be restored to the largest expanse of tidal wetlands in the Delta with no impact to agriculture. Frank's Tract levees were breached and the island has been flooded since the early 1900s. The subsided island is deep and provides warm-water habitat for predatory, non-native fish. The island bed must be elevated through a combination of dredge disposal, natural sediment accretion, and peat accumulation. Frank's Tract will be a functional component of the San Joaquin River corridor, a major fish rearing and migration area. Reclaiming the tract must also occur in conjunction with the eradication and control of nuisance, introduced aquatic plants for restoration to be most beneficial to native species.	▪ Use multiple techniques to restore tidal habitats, including physical creation, natural sediment accretion. ▪ Use of dredge material to build wetlands.	Breached diked tidal wetland evaluation. CALFED Water Quality Program.
22. Restore tidal wetlands on Decker Island on the Port of Sacramento property. *(floodplain/marsh, river geomorphology)*	Restoration of tidal wetlands on the upper half of Decker Island owned by the Port of Sacramento will provide habitat along the Sacramento River for migrant Sacramento salmon and for delta smelt. The dredge spoils located on Port half of the island may have to be removed to return the island to tidal elevations.		Decker Island tidal wetland enhancement (DFG property).
23. Evaluate species utilization of tidal wetlands on Big Break. *(population management)*	Big Break is a flooded Delta tract with a large expanse of shallow-water habitat. The island can serve as a reference site for species utilization of shallow-water habitat.	• Residence time and rearing of San Joaquin River salmon, delta smelt, and other native species.	

24. Restore seasonal wetlands on Twitchell Island. *(floodplain/marsh)*	Restoration of seasonal wetlands on Twitchell Island will provide habitat for migratory birds.		
25. Restore seasonal wetlands on Sherman Island. *(floodplain/marsh)*	Restoration of seasonal wetlands on Sherman Island will provide habitat for migratory birds.		
26. Restore in-channel islands throughout the Delta. *(floodplain/marsh, river geomorphology)*	In-channel islands are important habitats that do not require acquisition of easements or land. Natural sediment transport processes can be used to create and maintain these habitats.	▪ Use multiple techniques to protect existing habitats from boat wakes and use natural processes to create and maintain.	CALFED Levee Program and Conveyance element. In-channel islands demonstration project.

Suisun Marsh Restoration Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
27. Restore tidal wetlands on Suisun Marsh and Van Sickle Island. *(floodplain/marsh, river geomorphology)*	Restoration of tidal wetlands will provide habitat for native fishes, rare plants and wildlife. It will also expand the spatial extent of the low-salinity zone (zone of high biological productivity) to increase estuarine productivity.	• Effects of tidal marsh restoration on estuarine productivity.	Hill Slough tidal restoration pilot project.
28. Screen priority I, II and III diversions in Suisun Marsh. *(entrainment, population management,)*			

North Bay Restoration Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
29. Napa/Sonoma Marsh, Petaluma Marsh, Napa River floodplain restoration and acquisition. *(floodplain/marsh, river geomorphology)*	Protection, enhancement and restoration of North Bay tidal marsh and floodplain will benefit clapper rail, black rail, salt marsh harvest mouse and other salt marsh species. In high outflow years, Delta fishes also utilize North Bay habitats.	• Evaluate species utilization of restored habitats.	
30. Develop incentives for wildlife-friendly agriculture in the North Bay. *(education)*	Agricultural fields provide surrogate habitat for resident and migratory wildlife.		

General Delta Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
31. Prevent introductions of exotic species throughout the Bay-Delta system through multiple strategies including: ▪ educating the public of harmful impacts ▪ outlawing the sale or transportation of nuisance species *(introduced species, education)*	Introduced species have had a profound, adverse impact on the entire Bay-Delta watershed and its species.		CA State Management Plan for Aquatic Nuisance Species.
32. Develop ballast water management program to halt the introduction of introduced species into the estuary. *(introduced species)*	The single largest source of nuisance species in the Bay-Delta is from ship ballast water discharged to San Francisco Bay. This is a cautious, preventative measure.		Ballast prevention program.

33. Develop control strategies for nuisance aquatic plants in the Delta, Suisun Marsh, and North Bay. *(introduced species)*	Introduced plants such as water hyacinth, *Egeria*, and *Elodia* have taken over large areas of the Delta, clogging water diversion intakes, hampering navigation, and providing vegetative cover preferred by non-native, predatory fishes. Control of these plants will have benefits to multiple beneficial uses of the Delta and may create conditions more favorable to native species.	• Ability to control nuisance aquatic plants. • Extent to which non-native plants favor non-native fishes over natives.	
34. Study the effects of *Potamocorbula amurensis* on the foodweb and, as appropriate, develop control strategies. *(introduced species, population management)*	*Potamocorbula* have decreased estuarine primary productivity, the effects of which have traveled throughout the foodweb, including upper trophic level species. Restoration of marshes may offset some of this lost productivity, but may not be great enough to overcome the effects of the clam unless its population abundance is reduced. There are presently no known, viable control methods for this species.	• Extent to which *Potamocorbula* limiting to restoration of native species. • Extent to which effects of *Potamocorbula* can be overcome with other measures. • Ability to control *Potomocorbula.*	
35. Restore and rehabilitate riparian and shaded riverine aquatic habitat along all practicable reaches of major fish migration corridors in the Delta including the Sacramento River, San Joaquin River, Steamboat Slough, and Georgiana Slough. *(floodplain/marsh)*	Provide cover and forage for migrating and rearing fish.	• Track indicator of salmon smolt survival. CWT (paired) experiments to assess baseline and changes.	

36. Evaluate the feasibility of propagating special-status plants species in the Delta. *(population management)*	There are numerous plants in the Delta, including many endemic species, which are listed as threatened, endangered or other special-status. In many cases the ecological requirements of the plants are unknown. Experimental propagation may identify the ecological requirements. It may be more feasible to reintroduce propagated plants rather than reproduce the habitat requirements of the plants.		
37. Develop a sediment budget (fine and coarse sediments) for the Delta. Monitor the effects of different flow events and other upstream events on sediment transfer to the Delta. *(floodplain/marsh, river geomorphology)*	Sediment supply to the Delta has decreased due to a loss of coarse sediment supply caused by dams, gravel mining, disconnection of floodplains, and water quality improvement actions. This loss of sediment may contribute to diminishment of Delta wetland habitats.		USGS sediment movement and availability study.
38. Determine the relationship between turbidity, primary productivity and potential eutrophication in the Bay and Delta. *(water quality)*	The relationship between turbidity, primary productivity and potential eutrophication in the Bay and Delta is not well understood. One hypothesis suggests that the decrease in turbidity from water quality improvement actions may increase light penetration, potentially leading to eutrophication.		
39. Evaluate the effectiveness of pulse flows from the San Joaquin River to improve salmon outmigration and to move juvenile salmon away from the South Delta pumps. *(water management, population management)*	There are conflicting hypotheses as to survival of outmigrant San Joaquin salmon. Current management emphasizes pulse flows intended to reduce entrainment in South Delta pumps. Conversely, pulse flows may reduce juvenile salmon survival rates by pushing them away from rearing areas too quickly.	• Track indicator of salmon smolt survival. CWT (paired) experiments to assess baseline and changes.	VAMP

40. Evaluate residence time of rearing and outmigration of San Joaquin River juvenile salmon. *(water management, population management, entrainment)*	The residence time of salmon on the San Joaquin River is unknown. Determining the residence time will help determine to what extent habitat restoration will benefit salmon.	• Track indicator of salmon smolt survival. CWT (paired) experiments to assess baseline and changes.	VAMP San Joaquin River ERP actions.
41. Evaluate the need to screen small diversions in the Delta. *(entrainment, population management)*	Unlike in riverine environments where unscreened diversions may affect a large portion of fish, the benefits of screening small diversions throughout the Delta is unknown. An evaluation should be undertaken to identify diversion effects on species and locations in the Delta where screening small diversions is a high priority.		

CALFED ECOSYSTEM RESTORATION PROGRAM
DRAFT STAGE 1 ACTIONS
SAN JOAQUIN RIVER BASIN

Tuolumne River Stage 1 Actions

The Tuolumne River has been selected as a demonstration stream, one of three Bay-Delta tributary creeks or rivers selected for large-scale implementation of restoration actions to significantly restore ecological processes and resources while simultaneously testing restoration hypotheses as part of an adaptive management approach. Lessons learned restoring the Tuolumne River will help the design and refinement of future restoration actions on the Tuolumne River and other Bay-Delta tributaries.

The Tuolumne has been selected as a demonstration stream to represent tributaries of the San Joaquin Basin. Because it generally has the highest volume of inflow (1.9 MAF) of the three tributaries to the San Joaquin River, it generally provides greater opportunity to re-operate reservoir releases to achieve ecological purposes. Historically, the Tuolumne River also contributed a larger percentage to Central Valley salmon escapement than the other tributaries to the San Joaquin River, so emphasizing restoration in this river has the potential to provide more benefits to stabilizing populations of anadromous fish.

Action (Restoration Coord. Program action type in parentheses)	**Rationale**	**Adaptive Management Design**	**Linkages** (Category III, related programs, etc.)
42. Improve base flows below Don Pedro Dam. (Note: this water will be part of the 100 TAF of water purchased to improve stream flows in the Sacramento and San Joaquin Basins.) *(water management)*	Improving base flows will improve fish migration in the river, increase the amount of spawning habitat available for fall-run chinook salmon, and help lower water temperatures that often can be stressful or lethal to anadromous and resident fish species. DFG has determined that current flow releases ordered by the FERC relicensing for the New Don Pedro Project may not be sufficient in all water years to benefit anadromous species. Also, current flow releases represent minimum instream needs; augmenting minimum instream flows will move toward establishing more optimal flows. Increased flows will be consistent with the objectives of the Vernalis Adaptive Management Program (VAMP).		VAMP

43. Conduct a feasibility study to construct setback levees, and purchase accompanying flood easements. *(floodplain/marsh, river geomorphology)*	The Tuolumne River currently has a capacity to convey approximately 9,000 cfs. The 1997 peak flow on the Tuolumne was 60,000 cfs. The Governor's Flood Emergency Action Team recommended that the Army Corps of Engineers examine increasing the channel capacity of the Tuolumne to accommodate a volume of 20,000 cfs. Constructing setback levees could help to provide increase floodway capacity while providing ecological benefits, such as restoring stream meander and reconnecting channels with a larger percentage of their historical floodplains.	If it is feasible to setback levees, then: • monitor and compare the amount and quality of aquatic and riparian habitat available in reaches narrowly confined by levees and reaches where the creek can meander within setback levees. • monitor rates of gravel recruitment, transport, and retention in leveed vs. non-leveed reaches. • compare flood stage levels and associated flood risk with historical levels for a given amount of inflow.	
44. Evaluate the use of reservoir re-operation to reduce stream temperatures. *(water management)*	Elevated stream temperatures in the Tuolumne can be stressful or lethal to salmon eggs, fry, and smolts, and they can delay the spawning migration of adults that must linger downstream until the temperature regime is suitable. Re-operating reservoir releases could provide a more beneficial temperature regime for anadromous and resident fish.	• Determine relationship between flow and temperature.	
45. Evaluate the effects of agricultural return flow and reduced groundwater infiltration on stream temperatures. *(water quality, water management)*	Several factors contribute to elevated stream temperatures in the Tuolumne, including reservoir construction, the removal of riparian vegetation, dredger ponds, irrigation return flows, and lined diversion canals which reduce groundwater infiltration to the stream's base flow. Reconfiguring dams or re-operating reservoir releases may not be sufficient to reduce stream temperatures necessary to restore anadromous and resident fish. It will be important to determine the extent to which agricultural return flows and reduced groundwater infiltration contribute to elevated stream temperatures and to	• Re-vegetate drainage ditches with riparian vegetation and compare water temperatures of drainage water entering the main channel with those of drainage ditches lacking riparian vegetation. • Replace sections of concrete-lined irrigation canals and drainage ditches with earthen canals and compare the rate of groundwater seepage, groundwater	

	develop solutions if the study demonstrates this to be a significant stressor.	discharge to the main channel, and local water temperatures with those of lined canals.	
46. Screen small pumps or provide alternative water sources. *(entrainment, water management)*	Thirty-six small, unscreened irrigation pump diversions have been identified on the lower Tuolumne River. Diversions can entrain juvenile salmon migrating downstream, especially since out-migration generally coincides with irrigation needs. Cumulatively, these small diversions can represent a significant impact upon the number of juvenile salmon that emigrate successfully. Providing alternative water supplies or screening these small diversions could decrease the effects of entrainment on migratory and resident fish populations.	• Compare rates of entrainment for screened small diversions with changing the timing of diversions.	
47. Isolate gravel pits connected to the river channel. *(river geomorphology)*	Old gravel mining operations created large pits in Tuolumne River floodplains. Insufficient levees designed to separate the mining pits from the river have been breached during high flow events. The dredger pits can elevate water temperatures, and they provide habitat for both native and exotic fish species that prey upon juvenile anadromous fish. Isolating these pits from the active channel could help to reduce water temperatures and the loss of juvenile fish to unnaturally high levels of predation.	• Estimate rates of predation upon juvenile anadromous and resident fish species by non-native, warm water fish species. • Evaluate water temperatures in the channel before and after dredger pits are isolated from the main channel. • Evaluate rates of gravel recruitment and transport before and after dredger pits are isolated from the main channel. • Compare interaction between surface flow and groundwater flow in vicinity of isolated dredger pits with reaches not bordered by dredger pits to estimate the amount of surface water lost from the stream channel to dredger pits.	FY' 97 Category III funds were provided to help fill in or isolate gravel mining pits in several reaches of the Tuolumne River and to add spawning-sized gravels to the channel.

48. Protect and restore riparian habitat. *(floodplain/marsh)*	Protecting and restoring riparian habitat will help to reduce stream temperatures, provide cover for juvenile fish, and habitat for numerous wildlife species. Mechanisms for protecting and restoring riparian habitat include providing assistance to landowners to stimulate voluntary efforts, purchase of conservation easements from willing sellers, or purchase of title from willing sellers.		
49. Restore the sediment regime by relocating instream gravel mining operations and evaluating the need to augment gravel supplies. *(river geomorphology)*	The construction of dams and gravel mining in the active channel reduce the amount of gravel available to form important aquatic and riparian habitat. Since it is infeasible to reduce the effects of dams upon the sediment regime, it is critical to relocate instream gravel mining from the active channel. It may also be necessary to artificially introduce additional gravel supplies to offset the impacts of dams upon natural sediment transport processes; however, additional study will be needed to determine the need and extent of gravel augmentation projects.		
50. Increase enforcement to reduce illegal harvest of fish. *(population management)*	Low flow conditions in the Tuolumne confine spawning chinook salmon and steelhead to narrow channels that make them vulnerable to poaching. Increasing enforcement efforts, in addition to improving base flows, will help to reduce poaching impacts.		

Merced River Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
51. Isolate dredger pits from the active river channel. *(river geomorphology)*	Old gravel mining operations created large pits in Merced River floodplains. Insufficient levees designed to separate the mining pits from the river have been breached during high flow events. The dredger pits can elevate water temperatures, and they provide habitat for both native and exotic fish species that prey upon juvenile anadromous fish. Isolating these pits from the active channel could help to reduce water temperatures and the loss of juvenile fish to unnaturally high levels of predation	• Estimate rates of predation upon juvenile anadromous and resident fish species by non-native, warm water fish species. • Evaluate water temperatures in the channel before and after dredger pits are isolated from the main channel. • Evaluate rates of gravel recruitment and transport before and after dredger pits are isolated from the main channel. • Compare interaction between surface flow and groundwater flow in vicinity of isolated dredger pits with reaches not bordered by dredger pits to estimate the amount of surface water lost from the stream channel to dredger pits.	FY' 97 Category III funds were provided to help fill in or isolate gravel mining pits.

Mainstem San Joaquin River Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
52. Purchase water rights to augment flows. (Note: this water will be part of the 100 TAF of water purchased to improve stream flows in the Sacramento and San Joaquin Basins.) *(water management)*	Additional water is needed to augment flows on the San Joaquin River below the Merced River to provide attraction flows for adult salmonids and out-migration flows for juvenile salmonids. Additional flows may also have the benefit of diluting pollutants and reducing diversion effects in the South Delta.		
53. Incorporate ecosystem improvements with the Sacramento and San Joaquin River Basins Comprehensive Study. *(floodplain/marsh, river geomorphology)*	The U.S. Army Corps of Engineers, the California Reclamation Board and the Department of Water Resources is conducting the Comprehensive Study to develop a strategy to reduce flood damage while incorporating ecosystem restoration through structural and non-structural measures. This is an opportunity to cost-effectively restore large expanses of ecologically important floodplains while improving flood protection by through cost sharing and integrated project design and implementation. A variety of measures including levee setbacks and riparian restoration on the mainstem San Joaquin River would meet objectives of the Comprehensive Study and the Ecosystem Restoration Program.		

CALFED ECOSYSTEM RESTORATION PROGRAM
DRAFT STAGE 1 ACTIONS
SACRAMENTO RIVER BASIN

Mainstem Sacramento River Stage 1 Actions			
Action (Restoration Coordination Program action type in parentheses)	**Rationale**	**Adaptive Management Design**	**Linkages** (Category III, related programs, etc.)
54. Evaluate the need to screen all diversions smaller than 100 cfs on both the mainstem Sacramento River and selected tributaries. *(entrainment)*	There are numerous small diversions of water from the Sacramento River and its tributaries. While many large diversions have fish screens to reduce the entrainment of fish, many small diversions are unscreened. The individual and cumulative losses of fish from these small diversions are unknown. Estimating the entrainment losses at small diversions, and comparing the effectiveness of fish screens with changes in the timing or location of small unscreened diversions will help to quantify and balance the benefits of potentially reduced entrainment with the costs of fish screening facilities. (CVPIA actions include screening all diversions on the Sacramento River greater than 250 cfs.)	• Evaluate the effectiveness of timing diversions to reduce impacts upon juvenile anadromous fish • Study the loss of juvenile anadromous fish to entrainment in smaller diversions	Category III, FY '98—Pelger Mutual Water Company: Small Fish Screen Evaluation: a study designed to quantify fish entrainment at two small diversion facilities (20 cfs), one of which is screened and one of which is unscreened.
55. Protect, enhance and restore the meander belt between Red Bluff and Chico Landing. *(floodplain/marsh, river geomorphology)*	The Sacramento River still meanders freely for more than 100 miles between Red Bluff and Chico Landing, dynamically eroding existing banks while forming new banks. Continuation of the SB 1086 effort to purchase riparian land or conservation easements will help protect and expand the existing meander belt, thereby preserving or enhancing many of the ecological processes and habitats that support a diversity of plant, fish and wildlife species.	• Compare the quantity and quality of aquatic and riparian habitat for freely meandering river reaches and reaches protected by rip-rap. • Determine the rate of gravel recruitment to the river from eroding banks.	Over $13 million in FY '97 and FY '98 Category III funds have been provided to acquire, restore, plan, and monitor the upper Sacramento River to help meet the objectives of the SB 1086 Upper Sacramento River Fisheries and Riparian Habitat Management Plan.

56. In conjunction with the USACE, Reclamation Board Comprehensive Study, evaluate the feasibility of setting back levees on the Sacramento River between Chico Landing and Verona. *(floodplain/marsh, river geomorphology)*	Setting back levees along the Sacramento River could reconnect the river with a portion of its floodplain, with the attendant ecological benefits, while simultaneously reducing flood risk. Setting back levees would enlarge the channel capacity to transport flood flows and provide floodplain storage, thereby reducing flood risk by reducing the pressure placed upon levees and by reducing peak flows.	If it is feasible to setback levees, then: • monitor and compare the amount and quality of aquatic and riparian habitat available in reaches narrowly confined by levees and reaches where the creek can meander within setback levees. • monitor rates of gravel recruitment, transport, and retention in leveed vs. non-leveed reaches. • compare flood stage levels and associated flood risk with historical levels for a given amount of inflow.	USACE, Reclamation Board Comprehensive Study
57. Evaluate the feasibility of re-vegetating levees on the Sacramento River between Verona and Collinsville. *(floodplain/marsh, river geomorphology)*	Current levee maintenance operations remove vegetation from levees to maintain channel capacities. Providing riparian habitat along the levees could benefit several wildlife species and provide valuable SRA habitat for aquatic species. Because riparian vegetation reduces channel capacity by increasing roughness, re-vegetation must proceed with improved flood management that reduces peak flows in the basin, or with setback levees that increase channel capacity.	• Evaluate local water temperatures in levee reaches with restored riparian habitat versus levee reaches without riparian habitat. • Compare the quantity and quality of aquatic and riparian habitat for levee reaches with restored riparian habitat versus levee reaches without riparian habitat.	
58. Install a fish barrier at Colusa Drain to prevent fish from straying into agricultural drainage ditches with low habitat value. *(fish passage)*	Agricultural return flows draining from the Colusa Drain into the Sacramento River can attract adult anadromous fish migrating upstream to spawn. There is no high-quality spawning habitat in the Colusa Drain, so adults that stray into the Colusa Drain subsequently become stranded and are lost to the spawning population. Creating a migration barrier will prevent adult anadromous fish from straying into the Drain.	• Compare numbers of anadromous fish stranded in Colusa Drain before and after construction of fish barrier.	

Deer Creek Stage 1 Actions

Deer Creek has been selected as a demonstration stream, one of three Bay-Delta tributary creeks or rivers selected for large-scale implementation of restoration actions to significantly restore ecological processes and resources while simultaneously testing restoration hypotheses as part of an adaptive management approach. Lessons learned restoring Deer Creek will help the design and refinement of future restoration actions on the creek and other Bay-Delta tributaries.

Deer Creek has been selected as a demonstration stream to represent tributaries of the northern Sacramento Basin draining the Sierra Nevada and the Cascade Range. Deer Creek has been selected because of the relative lack of development in the watershed and because it provides the best opportunity to restore spring-run chinook salmon in the Sacramento Basin. Because it drains land underlain by volcanic formations around Mount Lassen, Deer Creek maintains a higher base flow because of higher groundwater discharge to the channel during the summer and fall low-flow season. The groundwater discharge also keeps water temperatures cool during the warm summer months. Relatively higher base flows of cool water help provide habitat for spring-run chinook salmon and steelhead trout, who rely upon cold water pools during warm summer months as they wait to spawn in the fall.

Action	Rationale	Adaptive Management Design	Linkages
59. In conjunction with USACE, DWR and local stakeholders, initiate a feasibility study to setback levees along Deer Creek. *(floodplain/marsh, river geomorphology)*	Levees currently constrict Deer Creek to a relatively narrow channel and prevent the creek from meandering naturally, which prevents the formation of diverse aquatic and riparian habitats. By constricting the channel Deer Creek levees also increase the shear stress applied to the channel bed during peak flows, which can wash important spawning gravels out of the channel. Setting back levees could provide Deer Creek with more room to meander and re-connect the creek with a portion of its floodplain. Setback levees could also increase channel capacity, thereby reducing flood pressure upon levees and reducing the risk of failure.	• If it is feasible to setback levees, then monitor and compare the amount and quality of aquatic and riparian habitat available in reaches narrowly confined by levees and reaches where the creek can meander within setback levees. • If it is feasible to setback levees, then monitor rates of gravel recruitment, transport, and retention in leveed vs. non-leveed reaches. • If it is feasible to setback levees, then compare flood stage levels and associated flood risk with historical levels for a given amount of inflow.	Potential future linkage--USACE Comprehensive Study

60. Re-connect the creek channel with a portion of its floodplain by purchasing flood easements from willing sellers. *(floodplain/marsh, river geomorphology)*	Levees along Deer Creek were breached during the flood of 1997. Purchasing flood easements from willing sellers along Deer Creek could help reconnect the stream with a portion of its floodplain while simultaneously providing flood storage to attenuate downstream peaks.	• If it is feasible to re-connect the stream channel with a portion of its floodplain through setback levees or flood easements, then monitor the amount of floodplain storage and rates of water percolation to groundwater. • Monitor the flow of nutrients from floodplain lands to the stream channel. • Determine the extent to which anadromous fish species use floodplain land for refuge, spawning, or rearing. • Monitor the level of stranding of adult and juvenile anadromous fish.	Potential future linkage--USACE Comprehensive Study
61. Augment instream flows by purchasing water from willing sellers. (Note: this water will be part of the 100 TAF of water purchased to improve flows in the Sacramento and San Joaquin Basins.) *(water management)*	Diversions from Deer Creek can de-water the lower seven miles of Deer Creek and prevent the migration of anadromous fish. Recent changes in diversion practices by local landowners have helped to provide streamflow in recent years, but it will be important to secure a more long-term water supply to ensure sufficient passage flows.	• Determine the flows necessary to provide fish passage over obstacles • Evaluate the relationship between flows and water temperatures • Determine the flows necessary to transport and cleanse spawning gravels	

62. Develop a watershed management plan to control the erosion and transport of fine sediments to the stream channel, to restore riparian habitat, enhance base flows, and reduce water temperatures. *(watershed management)*	Excessive loads of fine sediment can degrade the spawning habitat and suffocate the incubating eggs of anadromous fish. It can also reduce the production of aquatic invertebrates, which are an important part of the food web. Carefully planned land use activities can help reduce untimely or excessive pulses of fine sediment into the stream channel. Restoring riparian habitat in a watershed can also help reduce the erosion and transport of fine sediments into the stream channel. Elevated stream temperatures can stress or kill both juvenile and adult anadromous fish in Butte Creek. Restoring riparian habitat can help retain stormwater runoff, allowing it to percolate into groundwater aquifers. Replenished aquifers may then contribute greater base flow, with cooler temperatures, to the channel during the summer and fall. Riparian habitat can also help reduce water temperatures by providing shading.	• determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed • evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel • as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow • as riparian vegetation is restored, evaluate its effects upon water temperatures	FY '98 Category III and CVPIA have provided funds to allow the acquisition or conservation easements for three properties on Deer Creek to protect or restore riparian habitat. FY '97 Category III funds have been provided to help implement the Deer Creek Watershed Management Strategy and to develop emergency response programs for wildfires, floods, and hazardous spills. FY '97 Category III funds have been provided to reduce erosion in the Deer Creek watershed.

Clear Creek Stage 1 Actions

Clear Creek has been selected as a demonstration stream, one of three Bay-Delta tributary creeks or rivers selected for large-scale implementation of restoration actions to significantly restore ecological processes and resources while simultaneously testing restoration hypotheses as part of an adaptive management approach. Lessons learned restoring Clear Creek will help the design and refinement of future restoration actions on the creek and other Bay-Delta tributaries.

Clear Creek has been selected as a demonstration stream to represent tributaries draining the Coast Range in the Sacramento Basin. Clear Creek has been selected because it has the potential to support populations of spring-run chinook salmon and steelhead trout. Clear Creek is also a target stream for CVPIA restoration actions, including flow releases from Clair Hill and Whiskeytown Dams for ecological purposes and cost-sharing funds allocated specifically for Clear Creek. Publicly owned land constitutes much of the lower Clear Creek watershed (NPS, BLM, CDFG), so full-scale, tributary-wide restoration will produce relatively fewer impacts upon private land.

Action	Rationale	Adaptive Management Design	Linkages
63. Relocate and rebuild McCormick-Saeltzer Dam to improve fish passage while preserving the diversion. *(fish passage)*	McCormick-Saeltzer Dam is a 15-foot high dam located on Clear Creek approximately 8 miles upstream of the confluence with the Sacramento River. The Dam can prevent the upstream migration of adult anadromous fish, blocking access to spawning habitat. Any juvenile fish emigrating downstream can suffer mortality or stress from their spill over the dam or from predation downstream of the dam. Category III funds have help finance a study to construct a new low-head dam (approximately 4 feet high at a flow of 150 cfs) with improved fish passage facilities, which would allow the removal of the current McCormick-Saeltzer Dam. Construction of the new facilities and removal of the existing dam will provide greater access to approximately 12 miles of spawning habitat above the dam.	• Compare use of available spawning habitat upstream of the dam by anadromous fish before and after re-configuration of the diversion facilities.	FY '97 Category III funds have been provided for the planning and design phases of relocating and reconfiguring McCormick-Saeltzer Dam to improve fish passage.

64. Provide channel maintenance flows to scour encroaching vegetation in the stream channel of lower Clear Creek. *(river geomorphology, water management)*	Reductions in peak flows caused by Whiskeytown Dam have allowed vegetation to establish within the stream channel in lower Clear Creek. The lack of channel-forming peak flows and the vegetation prevent the creek from naturally meandering, thereby preventing the recruitment of gravel and the diversity of aquatic and riparian habitat associated with naturally meandering streams. Providing sufficient scouring flows will help provide the energy to allow Clear Creek to meander naturally and periodically scour encroaching vegetation.	• Determine flows necessary to scour encroaching vegetation from the active channel. • Determine channel maintenance flows necessary to scour and transport sediment to provide surfaces for riparian vegetation succession.	
65. Evaluate the need to acquire water from willing sellers to help augment flows in Clear Creek. (This water will be part of the 100 TAF acquired to improve streamflow in the Sacramento and San Joaquin Basins.) *(water management)*	Whiskeytown Reservoir provides a source of water to help provide minimum instream flows necessary to allow fish passage over obstacles and to reduce stream temperatures. CVPIA provides for flows necessary to maintain ecological resources. It may be necessary to augment these flows to achieve more optimal conditions by purchasing water from willing sellers.	• Determine the flows necessary to provide fish passage over obstacles • Evaluate the relationship between flows and water temperatures • Determine the flows necessary to transport and cleanse spawning gravels	CVPIA allocates flow releases from Whiskeytown and Clair Hill Reservoirs.
66. Protect natural sources of gravel by relocating instream gravel mining from the active channel, evaluate the need to provide additional gravel augmentation projects, restore channel meander by removing dredger tailings, and restore a more defined channel by filling in captured dredger pits. *(river geomorphology)*	Gravel operators have halted instream gravel mining operations in Clear Creek in the last few years. Permanently relocating gravel mining from the active channel will protect natural sources of gravel for recruitment and distribution in the stream channel. Several gravel augmentation projects have already been implemented or planned for Clear Creek. Because Whiskeytown Dam traps all of the gravel from upstream reaches, it will be necessary to periodically add gravel to the downstream channel to compensate for the sediment trapped behind the dam. An early study can help determine if the current gravel enhancement projects are sufficient to provide adequate spawning gravels for the	• Monitor the transport and deposition of spawning gravels. • Evaluate introduced spawning gravels to see if they are suitably sized for spawning habitat for anadromous fish.	FY '98 Category III funds have been provided to restore two reaches of the creek by removing dredger tailings at one upstream site and using them to fill in dredger pits at a downstream site. The project will allow the restoration or riparian habitat on the upper reach, and it will fill in or isolate dredger pits on the downstream reach to prevent the predation and stranding of juvenile anadromous fish.

	Clear Creek system. Gravel mining in the lower reaches of the creek have enabled the creek to capture dredger pits and historical channels. As a result, the lower creek can lack a defined channel because flows are distributed through many historical channels, which can impede fish migration. The creek has also captured dredger pits, which can provide habitat for non-native, warm water fish species that prey upon emigrating juvenile anadromous salmon.		
67. Develop and implement a watershed management plan in conjunction with local landowners and local, state and federal agencies active in the watershed. *(watershed management)*	Human activities in the Clear Creek watershed can cause erosion that increases the load of fine sediments introduced to the stream channel. An excessive load of fine sediments can degrade spawning habitat by clogging or burying spawning gravels. Developing a watershed plan to help reduce the amount of fine sediment in the stream channel will help to improve the quality of spawning habitat for anadromous fish.	• determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed • evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel	Lower Clear Creek Watershed Evaluation (NRCS)
68. Protect and restore riparian vegetation on channel banks. *(river geomorphology, floodplain/marsh)*	Protecting existing riparian habitat and restoring denuded banks will help provide habitat for wildlife, provide SRA habitat for fish, reduce stream temperatures by shading, and prevent the transport of fine sediments to the stream channel.	• as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow • as riparian vegetation is restored, evaluate its effects upon water temperatures	

Mill Creek Stage 1 Actions

Mill Creek is a relatively healthy watershed that provides one of the few opportunities for increasing the abundance of spring-run chinook salmon. Because it drains land underlain by volcanic formations around Mount Lassen, Mill Creek maintains a higher base flow because of higher groundwater discharge to the channel during the summer and fall low-flow season. The groundwater discharge also keeps water temperatures cool during the warm summer months. Relatively higher base flows of cool water help provide habitat for spring-run chinook salmon and steelhead trout, who rely upon cold water pools during warm summer months as they wait to spawn in the fall.

Action	Rationale	Adaptive Management Design	Linkages
69. Prevent re-construction of Clough Dam by providing alternative means of diversion that does not impede fish migration. *(fish passage)*	Clough Dam was breached in the January 1997 flood. Rather than rebuilding the privately owned diversion dam and equipping it with fish passage facilities, it would be preferable to provide an alternative water supply to the water right holder that would allow the permanent removal of Clough Dam, thereby granting unobstructed passage to migrating anadromous fish.	Since the dam has already been breached naturally, there is relatively little opportunity to design an adaptive management experiment to improve our knowledge of local ecological relationships and functions related to fish obstruction, other than continuing to monitor escapement rates and compare against historical data.	FY '98 Category III funds have been provided to allow the planning, design, and construction of alternative water diversion facilities that will allow removal of Clough Dam and improved fish passage.
70. Develop a watershed management plan to reduce input of fine sediment to the stream channel, and to enhance base flows by retaining stormwater runoff. *(watershed management)*	Spawning habitat in lower Mill Creek has been degraded by an excessive load of fine sediment that is cementing the spawning gravels. Mill Creek drains a watershed underlain principally by volcanic deposits that naturally contribute a relatively large load of fine sediments to the channel. Untimely pulses of additional fine sediment caused by human activities--such as timber harvest, road construction, and cattle grazing--could further degrade spawning habitat. Developing a watershed management plan with local landowners and local, state and federal agencies active in the watershed could help prevent untimely pulses of additional fine sediment that could bury and suffocate the incubating eggs of anadromous fish.	• determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed • evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel • as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow • as riparian vegetation is restored, evaluate its effects upon water temperatures	FY '98 Category III funds have been provided to allow the acquisition of a conservation easement for a property on Mill Creek to protect or restore riparian habitat. FY '97 Category III funds have been provided to reduce erosion in the Mill Creek watershed. FY '97 Category III funds have been provided to restore riparian habitat on lower Mill Creek.

71. Augment instream flows by purchasing water from willing sellers. (Note: this water will be part of the 100 TAF of water purchased to improve stream flows in the Sacramento and San Joaquin Basins. *(water management)*	Diversions from Mill Creek can de-water the lower 8 miles of Mill Creek and prevent the migration of anadromous fish. Recent water exchange agreements have provided alternative water supplies for local water right holders who have reduced or eliminated their diversions. Expanding and making permanent this water exchange program, or purchasing additional water from willing sellers, can help ensure adequate streamflow to allow fish passage and to help reduce stream temperatures.	• Determine the flows necessary to provide fish passage over obstacles • Evaluate the relationship between flows and water temperatures • Determine the flows necessary to transport and cleanse spawning gravels	

Battle Creek Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
72. Remove diversion dams or construct fish passage facilities for hydropower facilities. *(fish passage)*	PG&E owns and operates two small reservoirs and seven unscreened diversions on Battle Creek and its tributaries. The facilities can impede the migration of juvenile and adult anadromous fish, and the unscreened diversions can entrain juvenile anadromous fish. Removing dams and diversions, where possible, will provide greater access to spawning and rearing habitat and reduce entrainment losses of anadromous fish. For those facilities that are not removed, equipping them with fish passage facilities and screening the currently unscreened diversions will also help to improve access to habitat and reduce entrainment.	• Compare escapement rates and use of spawning habitat upstream of diversion facilities before and after removal. • Compare use of available spawning habitat above hydropower facilities before and after construction of fish passage facilities.	FY '97 Category III funds have been provided for planning and design of fish passage and fish screening facilities for several diversions structures in Battle Creek.
73. Improve streamflows. *(water management)*	The PG&E hydropower facilities on Battle Creek were capable of diverting up to 98% of the streamflow, which impeded fish passage and elevated stream temperatures. An interim agreement provided for re-operation of the hydropower facilities to provide a greater volume of flow. It is important to provide a long-term solution to ensure adequate streamflows downstream of the hydropower facilities.	• Determine the flows necessary to provide fish passage over obstacles • Evaluate the relationship between flows and water temperatures • Determine the flows necessary to transport and cleanse spawning gravels	CVPIA funds have helped to provide interim flows until a long-term flow agreement is reached.
74. Improve the fish passage facilities at the Coleman National Fish Hatchery. *(fish passage)*	Coleman National Fish Hatchery has a weir equipped with a fish ladder. The fish ladder provides access to upstream spawning habitat for spring-run and winter-run chinook salmon. The weir is designed to prevent fall-run chinook salmon from migrating upstream to spawn to prevent hybridization of the species. Improving the weir to better block upstream access to fall-run chinook salmon will help to preserve the genetic integrity of Battle Creek salmonids.		Battle Creek Conservancy, FWS

Cottonwood Creek Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
75. Relocate gravel mining operations from the active channel. *(river geomorphology, floodplain/marsh)*	Cottonwood Creek is undammed, and it has become the primary source of spawning gravels for the Sacramento River since the construction of Shasta Dam. Current gravel mining operations in the active channel of Cottonwood Creek remove gravel that would otherwise maintain spawning habitat not only in the lower reaches of Cottonwood Creek, but also in the Sacramento River downstream of its confluence with Cottonwood Creek. Relocating gravel mining operations from the active channel will restore the natural transport of gravel and provide needed sediment.	• Evaluate rates of gravel recruitment to the channel from channel erosion of bank deposits and events in the watershed such as wildfires and landslides	
76. In concert with local stakeholders and local, state, and federal public agencies, develop a watershed management plan to reduce the amount of fine sediment introduced to the stream channel, to restore riparian and SRA habitat, to improve base flows, and to reduce water temperatures. *(watershed management)*	Salmon spawning habitat in the lower reaches of Cottonwood Creek are degraded by excessive loads of sand and silt owing to poor management practices in the watershed—such as timber harvest, road construction and cattle grazing. Excessive loads of finer sediment can bury or clog important spawning gravels and suffocate incubating eggs or prevent fry from emerging from gravels. Working with land owners and state and federal land agencies to implement procedures to reduce erosion in the watershed, and revegetating the banks of stream channel with riparian habitat will reduce the transport of fine sediment to the channel. Restoring riparian habitat can also help retain stormwater runoff, allowing it to percolate into groundwater aquifers. Replenished aquifers may then contribute greater base flow, with cooler temperatures, to the channel during the summer and fall. Riparian habitat can also help reduce water temperatures by providing shading.	• determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed • evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel • as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow • as riparian vegetation is restored, evaluate its effects upon water temperatures	FY '98 Category III funds have been provided to allow the formation of the Cottonwood Creek Watershed Group.

Butte Creek Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
77. Provide alternative water sources to allow removal of diversion dams, or equip the diversion dams with improved fish passage facilities. *(fish passage, water management)*	Category III funds have been provided to fund the planning and design phases for the removal of several diversion dams on Butte Creek. Removing these dams will provide better access to spawning and rearing habitat for anadromous fish. It will be important to evaluate the potential removal or upgrading of fish passage facilities for the remaining diversion dams on the creek.		FY '97 Category III and CVPIA funds have been provided for the planning, design and construction of fish passage facilities and diversion screens at Adams Dam and Gorrill Dam. CVPIA funds have been provided for planning costs of improving fish passage at seven diversions on Butte Creek.
78. Augment instream flows by purchasing water from willing sellers. (Note: this water will be part of the 100 TAF of water purchased to improve stream flows in the Sacramento and San Joaquin Basins. *(water management)*	In dry years, insufficient flow in Butte Creek can impede the upstream passage of adult anadromous fish. Low flows and elevated water temperatures can stress or kill adult spring-run chinook salmon over-summering in the creek, as well as juvenile fish rearing or emigrating in the river. Providing additional flows can help to maintain passage flows and reduce water temperatures during dry years, thereby increasing both adult and juvenile survival for multiple fish species.	• Determine the flows necessary to provide fish passage over obstacles • Evaluate the relationship between flows and water temperatures • Determine the flows necessary to transport and cleanse spawning gravels	

79. Develop a watershed management plan to control the erosion and transport of fine sediments to the stream channel, to restore riparian habitat, enhance base flows, and reduce water temperatures. *(watershed management)*	Excessive loads of fine sediment can degrade the spawning habitat and suffocate the incubating eggs of anadromous fish. It can also reduce the production of aquatic invertebrates, which are an important part of the food web. Carefully planned land use activities can help reduce untimely or excessive pulses of fine sediment into the stream channel. Restoring riparian habitat in a watershed can also help reduce the erosion and transport of fine sediments into the stream channel. Elevated stream temperatures can stress or kill both juvenile and adult anadromous fish in Butte Creek. Restoring riparian habitat can help retain stormwater runoff, allowing it to percolate into groundwater aquifers. Replenished aquifers may then contribute greater base flow, with cooler temperatures, to the channel during the summer and fall. Riparian habitat can also help reduce water temperatures by providing shading.	• determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed • evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel • as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow • as riparian vegetation is restored, evaluate its effects upon water temperatures	FY '97 and FY '98 Category III funds have been provided for watershed planning, research, education, and riparian restoration activities in Butte Creek watershed.

Feather River and Yuba River Stage 1 Actions

Action	Rationale	Adaptive Management Design	Linkages
80. Evaluate options to improve fish passage upstream and downstream of Daguerre Point Dam on the Yuba River. *(fish passage)*	Daguerre Point Dam can impede the migration of anadromous fish. Past efforts to equip the dam with adequate fish passage facilities have been largely unsuccessful. Removing the dam would provide easier access to an additional 12 miles of upstream habitat.	• If it is feasible to remove Daguerre Point Dam, compare escapement rates and use of spawning habitat upstream of the dam before and after removal. • Compare rates of predation of juvenile anadromous fish downstream of the dam	Potential future linkage—USACE Comprehensive Study

81. Conduct a feasibility study of removing Daguerre Point Dam. *(fish passage)*		before and after removal.	
82. Evaluate options to improve fish passage upstream and downstream of Englebright Dam on the Yuba River. *(fish passage)* 83. Conduct a feasibility study of removing Englebright. *(fish passage)*	Englebright Dam is a debris dam constructed to trap sediment caused by mining operations in the upper watershed. It also provides re-regulation for hydropower facilities located upstream. Removal of the dam could provide access to upstream habitat and sediment for downstream reaches. A feasibility study is needed to evaluate the potential of upstream aquatic habitat, the quality and stratification of sediment stored behind the dam, and the potential removal of the dam.	• If it is feasible to remove Englebright Dam, monitor the transport of accumulated sediment in relation to flow events.	Potential future linkage—USACE Comprehensive Study
84. Screen the Sunset Pumps diversion on the Feather River. *(entrainment)*	Unscreened or poorly screened diversions can entrain juvenile anadromous fish. Since the Feather River supports important spring-run chinook, fall-run chinook, steelhead trout, and American shad populations, screening large diversions has the potential to contribute to the recovery or maintenance of several fish species.		

Cache Creek Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
85. Control or eradicate non-native riparian plants and re-vegetate with native plants. *(introduced species, river geomorphology, floodplain/marsh)*	Tamarisk has become established in the Cache Creek watershed. Tamarisk can alter ecological processes by inducing greater deposition, by evapotranspiring greater quantities of water than native riparian vegetation, and by altering soil chemistry. Tamarisk provides little habitat for native wildlife species, and because it grows vertically and doesn't overhang the stream channel, it doesn't provide the SRA habitat for aquatic species that native riparian vegetation does. Controlling or eradicating Tamarisk from the Cache Creek watershed will help prevent its spread into Yolo Bypass and the Delta. Replacing tamarisk with native riparian vegetation may also enhance base flows.	• Evaluate different removal and re-vegetation techniques to identify the most effective and cost-effective methods for controlling or eradicating non-native or invasive riparian plant species. • Monitor the rate of re-colonization by native, non-native, and invasive species. • Determine the ecological conditions or processes that favor native species over non-native species. • Determine invertebrate and wildlife use of non-native riparian plant species. • Determine the extent to which non-native riparian species alter ecological processes.	SWRCB funds have been provided for erosion and sediment control demonstration project on Cache Creek.
86. Fund studies to identify sources of mercury contamination and potential solutions for controlling mercury contamination. *(water quality)*	The Cache Creek watershed is a significant source of mercury contamination in the Bay-Delta ecosystem. Identifying sources of contamination methods for controlling the transport of mercury will help protect downstream water quality and habitats.	• Determine the toxicity and chemical availability of mercury to biota.	CALFED Water Quality Program

American River Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
87. Control or eradicate non-native riparian plants and re-vegetate with native plants. *(introduced species, river geomorphology, floodplain/marsh)*	Arundo has become established in the American River. Arundo can alter ecological processes by inducing greater deposition, by evapotranspiring greater quantities of water than native riparian vegetation, and by altering soil chemistry. Arundo provides little habitat for native wildlife species, and because it grows vertically and doesn't overhang the stream channel, it doesn't provide the SRA habitat for aquatic species that native riparian vegetation does. Controlling or eradicating Arundo from the Cache Creek watershed will help prevent its spread into Yolo Bypass and the Delta. Replacing Arundo with native riparian vegetation may also enhance base flows.	• Evaluate different removal and re-vegetation techniques to identify the most effective and cost-effective methods for controlling or eradicating non-native or invasive riparian plant species. • Monitor the rate of re-colonization by native, non-native, and invasive species. • Determine the ecological conditions or processes that favor native species over non-native species. • Determine invertebrate and wildlife use of non-native riparian plant species. • Determine the extent to which non-native riparian species alter ecological processes.	SWRCB funds have been provided for erosion and sediment control demonstration project on Cache Creek.
88. Improve drainage and reduce fish stranding on the lower American River floodplain. *(floodplain/marsh, fish passage)*	There is a series of small, disconnected sloughs and seasonal wetlands in the lower American floodplain at the base of the north levee. These sloughs, former levee borrow pits, fill with floodwaters in winter and spring and slowly drain to the East Natomas Drainage Canal and then to the American River. As floods recede, many small fish are stranded in the poorly-drained sloughs. Drainage of floodwaters and fish to the Natomas Canal and the American River can be facilitated by enlarging existing culverts, adding new culverts and removing other obstructions to connect the sloughs, and by grading channels to drain ponded areas to the sloughs.		

89. In balance with public safety, manage the removal of or introduce instream woody debris on selected river reaches to enhance aquatic habitat for salmonids. *(river geomorphology, floodplain/marsh)*	Woody debris is cleared from the American River channel for recreational and public safety purposes. However, woody debris provides important rearing and resting habitat for salmonids. Allowing woody debris to stay in selected reaches of the channel may enhance patches of salmonid rearing habitat without affecting recreation significantly.	• Compare salmonid use of aquatic habitat in reaches with woody debris and reaches cleared of woody debris.	

General Stage 1 Actions			
Action	**Rationale**	**Adaptive Management Design**	**Linkages**
90. Evaluate hatchery management and release operations to minimize threats to wild populations of anadromous fish. *(population management)*	Hatchery-produced fish may compete with or prey upon wild populations of anadromous fish. Yet hatchery-produced fish may be critical in maintaining viable populations of species through critical events such as dry years.	• Study rates of predation of wild populations of fish by hatchery produced populations.	
91. Restore seasonal wetlands and wildlife-friendly agricultural practices to support the Central Valley Habitat Joint Venture restoration goals for resident and migratory birds in Sutter, Colusa, Butte, and American Basins. *(floodplain/marsh, education)*	The ERP embraces the goals of the Central Valley Habitat Joint Venture, which has a goal of protecting, enhancing, and restoring seasonal wetlands for the benefit of migratory bird species. The ERP will focus on actions to enhance existing but degraded seasonal wetland habitat and in promoting wildlife-friendly agricultural practices.		